Mission Directorate:	Science
Theme:	Heliophysics

Theme Overview

The Earth resides in the extended atmosphere of an active star. While sunlight enables and sustains life, the Sun's variability produces streams of high energy particles and radiation that can harm life and important technology (such as satellites and power grids). Under the protective shield of its magnetic field and atmosphere, Earth is an island in the universe where life has developed and flourished.

The goal of the Heliophysics Division is to understand the Sun, heliosphere, and planetary environments as a single connected system. In addition to solar processes, this domain of study includes the interaction of solar plasma and radiation with Earth, other planets, and our galaxy. By analyzing the connections between the Sun, solar wind, the planetary space environments, and the galaxy, scientists are uncovering fundamental physical processes that occur throughout the universe. Understanding these processes will allow scientists to predict the impacts of solar variability on humans, technological systems, and even the presence of life itself.

Scientists have already discovered ways to peer into the internal workings of the Sun and understand how Earth's magnetosphere responds to solar activity. The challenge now is to explore the full system of complex interactions that characterize the relationship of the Sun with the solar system.

NASA's Heliophysics Division strives to answer the following big questions:

- How does solar variability affect human society, technological systems and the habitability of planets?
- What are the hazards and resources in the solar system environment that will affect the extension of human presence in space?
- How and why does the Sun vary and what are the consequences?
- What are the fundamental physical processes of the space environment?

A combination of interrelated elements is necessary to make progress in answering these questions. They include a complement of missions of varying sizes to collect new science data, timely development of technologies that enable new science, and acquisition of knowledge through research, analysis, theory, and modeling.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**787.6**	**591.6**	**605.0**	**672.6**	**720.5**	**742.7**	**762.6**
Heliophysics Research	183.3	195.9	178.6	178.1	183.1	190.6	194.3
Living with a Star	218.1	238.6	212.2	204.6	208.7	230.0	236.6
Solar Terrestrial Probes	71.9	123.1	143.0	169.1	170.6	160.8	164.3
Heliophysics Explorer Program	48.1	31.4	69.4	119.7	158.1	161.3	167.4
New Millennium	15.0	2.7	1.8	1.1	0.0	0.0	0.0
Near Earth Networks	40.9	0.0	0.0	0.0	0.0	0.0	0.0
Deep Space Mission Systems (DSMS)	210.3	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**840.9**	**577.3**	**598.9**	**689.4**	**741.2**	**746.6**	**--**
Heliophysics Research	181.2	184.8	180.3	175.3	179.8	187.5	--
Living with a Star	217.1	223.8	212.0	216.6	232.8	237.5	--
Solar Terrestrial Probes	105.9	123.1	137.5	171.4	172.6	161.5	--
Heliophysics Explorer Program	61.0	41.3	66.8	125.1	156.0	160.1	--
New Millennium	25.8	4.3	2.2	1.1	0.0	0.0	--
Near Earth Networks	39.5	0.0	0.0	0.0	0.0	0.0	--
Deep Space Mission Systems (DSMS)	210.5	0.0	0.0	0.0	0.0	0.0	--
Total Change from FY 2009 Request	**-53.3**	**14.3**	**6.2**	**-16.8**	**-20.7**	**-3.9**	**--**

Note: Starting in FY 10, the Astro-H project is in the Astrophysics theme.

Plans for FY 2010

Heliophysics Research

The Research program will continue to operate 16 missions and 27 spacecraft and conduct another senior review of these missions. Heliophysics data centers will continue to archive and distribute collected science data.

Living with a Star

The Solar Dynamics Observatory will launch in early FY10. NASA will award instrument contracts for the Solar Probe mission. The Radiation Belt Storm Probes (RBSP) mission will complete mission Critical Design Review.

Solar Terrestrial Probes

The Magnetospheric Multiscale Mission(MMS) will continue development work, progressing towards mission Critical Design Review. STEREO and Hinode will continue mission operations.

Heliophysics Explorer Program

Small Explorers (SMEX) selections (to be selected in 2009) will begin their formulation activities. The IBEX, CINDI, TWINS, AIM, and THEMIS missions will continue mission operations.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Heliophysics Program is guided by U.S. National Space Policy and follows NASA's tradition of establishing its priorities through consultation with world-class experts. Heliophysics relies on two advisory bodies for scientific assessments and decadal surveys: the National Research Council's Space Studies Board and the NASA Advisory Council.

Heliophysics missions such as the Advanced Composition Explorer provide critical data to the Department of Defense, the Federal Aviation Administration, and the National Oceanographic and Atmospheric Administration to guard against space weather impacts. The Living With a Star (LWS) program targets research and technologies that are relevant to the operational needs of these agencies. The nation's safety, security, and economy have become increasingly dependent on technologies that are susceptible to the extremes of space weather -- severe disturbances of the upper atmosphere and of the near-Earth space environment that are driven by the magnetic activity of the Sun. Space weather events can damage satellites and power grids, and disrupt air traffic communications. Inter-agency activities are coordinated through the National Space Weather Program Council (NSWPC) within the Office of the Federal Coordinator for Meteorology. Organizations around the world also access Heliophysics data via the International Space Environment Service.

Heliophysics is also working to improve our understanding of magnetic reconnection, a process that occurs throughout the universe when stressed magnetic field lines suddenly transition to a new shape. This understanding is expected to greatly benefit the Department of Energy's efforts in the area of fusion energy, as magnetic reconnection phenomena play a critical role in virtually every configuration that is being explored to confine high-temperature plasmas.

Internationally, NASA's Heliophysics Program plays a leadership role with both the International Heliophysical Year and International Living With a Star activities, leveraging space assets and resources to achieve greater scientific advancement now and in the future.

Relevance to the NASA Mission and Strategic Goals:

Heliophysics supports NASA's Strategic Plan Sub-Goal 3B: Understand the Sun and its effect on Earth and the solar system. This effort is comprised of three focus areas, or Outcomes:
3B.1: Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.
3B.2: Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.
3B.3: Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.

Heliophysics researchers study the Sun and its influence on the solar system. Using data from a group of spacecraft that form an extended network of sensors, NASA seeks to understand the fundamental physics behind Sun-planet interactions and study space environmental hazards. Improved understanding and observations of solar events and the interaction between Earth and the Sun will provide the information needed to develop early warning systems and technologies to protect astronauts, spacecraft, and the systems that support them from hazardous space radiation. This progress strengthens our nation's space leadership and creates a robust science and technology base supporting all of NASA's space activities.

See FY 2010 Performance Plan for specific annual goals.

Relevance to education and public benefits:

Society is increasingly dependent on modern technology, including power grids, global positioning, weather forecasting and satellite communications. The valuable assets that support these technologies are vulnerable to solar activity and space weather events, so the need to predict solar events and mitigate their effect is critical to the public's safety, security, and the Nation's economy. A newly released report by the National Academy of Sciences titled "Severe Space Weather Events -- Understanding Societal and Economic Impacts" for the first time attempts to quantify the effects of extreme space weather on the nation (www.nap.edu/catalog/12507.html). The report concludes that improving forecasting capabilities and raising public awareness are instrumental in mitigating severe consequences. The Heliophysics Program supports the rapid transition of research results, models and data into operational products that benefit the public and other segments of the United States Government.

Heliophysics education programs include the award-winning Family Science Night, which introduces local communities to a wide range of Heliophysics-related topics. The Program partners with Astrophysics and Earth Science for a multi-disciplinary approach to such topics as light and spectrum, the seasons, and solar power. The IBEX mission has partnered with Adler Planetarium in Chicago to develop a planetarium show that communicates the scientific goals and results of the IBEX mission. The STEREO mission regularly provides selected images and movies to over 250 science centers through the ViewSpace outreach program and the Astronomical Bulletins of the American Museum of National History in New York.

Mission Directorate:	Science
Theme:	Heliophysics

Performance Achievement Highlights:

The Explorer program achieved three successful launches in 2008. The Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS-B) mission was launched and is now providing (along with TWINS-A) the first ever 3-D images of the magnetosphere. The Coupled Ion-Neutral Dynamics Investigation (CINDI) instrument on the Communication/Navigation Outage Forecast System (C/NOFS) Air Force spacecraft is observing the ionosphere at the lowest recorded solar minimum. Interstellar Boundary Explorer (IBEX) was successfully launched in October 2008 to provide the first ever images of the heliosphere (a bubble in space produced by the solar wind). In addition, six Small Explorers (SMEX) proposals and the GOLD Mission of Opportunity were selected to complete concept study reports.

Time History of Events and Macroscale Interactions during Substorms (THEMIS) successfully completed the first tail season of its observing plan with five operational spacecraft resulting in significant progress in understanding how Earth's magnetic field stores energy from the solar wind until it is released, producing substorms.

After 18 years of operations, ULYSSES was decommissioned. In its final year, it detected the lowest solar wind velocities and densities (40% lower than during any solar cycle) ever recorded during solar minimum. At the same time Solar and Heliospheric Observatory (SOHO) measurements indicate that the Sun's polar fields are smaller by a factor of two. The change in strength suggests that the upcoming solar cycle may be significantly different than previous well-observed cycles.

The twin Solar Terrestrial Relations Observatory (STEREO) imagers have exceeded expectations with their ability to image the slow solar wind, co-rotating interaction regions, and coronal mass ejections. During 2007, STEREO observed a series of solar wind wave fronts sweeping past Earth.

SDO completed observatory-level testing and check-out and is ready for launch when an Atlas launch vehicle slot opens. MMS was approved to proceed into Phase B. Radiation Belt Storm Probes (RBSP) was recently confirmed to begin implementation and has started Phase C. The Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL) mission started Phase B and completed System Requirements Review. Space Environment Testbeds (SET) was successfully completed and shipped to the US Air Force for integration & testing on the Deployable Structures Experiment (DSX) spacecraft. Solar Probe Plus, a mission to study the origins of hazardous solar storms, started Pre-Phase A studies. NASA approved Solar Orbiter to enter Phase A and is developing a collaborative agreement for a joint mission with the European Space Agency (ESA).

In the New Millenium Program (NMP), the Space Technology 7 project completed development and a successful pre-ship Review. Sounding Rockets completed 12 suborbital launches, supporting seven science investigations, two technology demonstrations and one educational project.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	National Research Council	12/2003	The Decadal Research Strategy assessed the current status and future directions of NASA's programs in solar and space physics research. The report identifies broad scientific challenges that define the focus and thrust of solar and space physics research for the decade 2003 through 2013 and presents a prioritized set of missions, facilities, and programs designed to address those challenges.	12/2012
Relevance	NAC/Helio-physics Subcommittee	09/2006	Review of Heliophysics Strategic Plan including science and program implementation strategies and relevance to the NASA Strategies and goals. Review concluded that the Heliophysics program as defined in the recent roadmap can be carried out with the current funding profile. However, concerns exist with regard to R&A and Explorer program funding.	09/2009
Quality	Senior Review Panel	04/2008	All Heliophysics Operating Missions were reviewed for their continued relevance to the strategic goals of the Heliophysics division. All missions except FAST received satisfactory or excellent ratings.	04/2010
Performance	NAC/Helio-physics Subcommittee	07/2008	Reviews of selected annual performance goals as documented in Performance and Accountability Report (PAR). Review found that Heliophysics has achieved its annual goals, and made significant progress toward understanding our local space environment and the fundamental science that is beginning to enable a reliable space weather predictive capability.	07/2009

THIS PAGE INTENTIONALLY BLANK

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	183.3	195.9	178.6	178.1	183.1	190.6	194.3
Heliophysics Research and Analysis	33.0	31.0	35.4	38.4	39.1	40.1	41.1
Sounding Rocket Operations	51.0	77.4	66.5	67.5	68.9	71.4	73.1
Other Missions and Data Analysis	99.4	87.5	76.7	72.3	75.1	79.1	80.1
FY 2009 President's Budget Request	181.2	184.8	180.3	175.3	179.8	187.5	--
Heliophysics Research and Analysis	30.9	33.9	35.9	38.9	39.6	40.5	--
Sounding Rockets Operations	42.9	63.4	66.5	67.5	68.9	71.4	--
Other Missions and Data Analysis	107.3	87.5	77.9	69.0	71.4	75.5	--
Changes from FY 2009 Request	2.1	11.1	-1.7	2.8	3.3	3.1	--

Note: Reallocation of extended mission budget to other programs for extended mission operations.

Program Overview

The science of Heliophysics is a unique blend of Astrophysics and Meteorology, involving the study of the interactions between gravitational and magnetic forces. The Heliophysics Research Program supports investigations of the Sun and planetary space environments by operating 16 missions (involving 27 spacecraft) and processing, archiving and distributing the data they collect. This fleet of spacecraft undertaking Heliophysics investigations, spanning all the space above the Earth's lower atmosphere, and from the core of the Sun to the outermost reaches of the solar wind, is informally termed the "Heliophysics Great Observatory" since the aggregation of data from all the spacecraft results in research synergies that would not be possible otherwise.

Heliophysics Research & Analysis routinely solicits proposals in several broad areas in order to advance our knowledge in support of NASA strategic goals. In addition, NASA occassionally offers special solicitations to take advantage of research opportunities that arise from the current solar environment. The Research Program also funds scientific investigations based on suborbital platforms, such as balloons or sounding rockets, and maintains some of the vital communications infrastructure to do so at Wallops Flight Facility. The Research and Analysis and Guest Investigator Projects fund more in-depth scientific investigations using all of this collected data via a competitive process that is held each year.

Plans For FY 2010

The Research and Analysis Program will hold its annual competition for new research awards; approximately $15 million will be available for the competition resulting in approximately 90 new awards. Guest Investigator Program will also hold its annual competition for new awards with approximately $13 million available for new awards.

All missions operating beyond their prime phase will be evaluated by a NASA-sponsored Senior Review in April 2010 to determine their status and optimize the allocation of funding for FY 2011 and beyond in order to achieve NASA's strategic science goals. The Sounding Rockets Program will launch approximately 22 missions, from domestic and international locations. The Research Range will provide launch instrumentation for NASA suborbital programs and projects at both local and remote locations. Science Data and Computing Technology will continue to sustain the National Space Science Data Center and hold its annual competition for the Applied Information Systems Research where approximately $2 million will be available for new research awards.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Project Descriptions and Explanation of Changes

Heliophysics Research and Analysis

Research and Analysis comprises an ever-evolving suite of individual Principal Investigator-proposed investigations that cover the complete range of science disciplines and techniques essential to achieve the Heliophysics Theme objectives and to take full advantage of the scientific data collected by NASA missions. Research and Analysis covers four elements: Geospace Science, Low-Cost Access to Space, Solar and Heliospheric Physics, and Heliophysics Theory.

Geospace Science studies the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles (Earth's magnetosphere is emphasized, but studies of the magnetospheres of planets, comets, and other primordial bodies are also supported). Geospace Science deals with the physics of the mesosphere, thermosphere, ionosphere, and aurorae of Earth, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

Low-Cost Access to Space funds science investigations that may be completed through suborbital rocket or balloon flight of experimental instrumentation, as well as proof-tests of new concepts in experimental techniques that may ultimately find application in free-flying Heliophysics space missions.

Solar and Heliospheric Physics treats the Sun as a typical star, as the dominant, time-varying source of energy, plasma, and energetic particles in the solar system (especially concerning its influence on Earth). This project investigates the origin and propagation of the solar wind and magnetic field from the Sun to the Heliopause (the boundary between the solar wind and the interstellar medium), the acceleration and transport of energetic particles in the heliosphere and the interface of solar influence with the interstellar medium.

The Heliophysics Theory Program supports efforts to attack problems using relatively large "critical mass" groups of investigators that are beyond the scope of smaller research and technology efforts.

Sounding Rocket Operations

Sounding Rockets: This project funds all suborbital mission activities (payload integration, launch, and mission operation) that support science investigations funded in other parts of the research program. (Including Heliophysics and Astrophysics Research and Analysis programs and even exploration technology test and demonstration programs.) Sounding Rockets present unique low-cost platforms that provide direct access to Earth's mesosphere (50-90 kilometers), lower thermosphere (90-120 kilometers), and the Earth's magnetosphere (up to 1,500 kilometers). Because of their short duration and access to Earth's upper atmosphere and the space environment, sounding rocket suborbital missions also enable calibration under-flights of orbital missions, repeated proof-of-concept technology demonstration missions, and valuable end-to-end space mission experience for scientists and engineers learning to develop and execute discovery-oriented orbital missions.

Research Range: The Research Range effort funds NASA's only test range, located at Wallops Flight Facility, for launch of suborbital and orbital vehicles, supporting launch operations, tracking, telemetry and command (TT&C) capabilities. The Wallops Research Range also supports a mobile TT&C capability to support launches safely from a number of launch sites worldwide, many of which have limited capabilities of their own. The NASA Research Range is one of the few ranges in the Nation to offer a mobile capability. The Range maintains it own airspace and supports a wide variety of small launch vehicles, suborbital missions, and airborne missions utilizing non-FAA-certified vehicles such as unmanned aircraft systems.

Other Missions and Data Analysis

Following the commissioning and checkout phase of any spacecraft, Headquarters management responsibility for operations and data analysis transitions to the Heliophysics Research Program. (However, a number of operating spacecraft still receive funding from their respective development programs.) The Research Program is responsible for collecting, archiving, and distributing the data collected by all operating spacecraft. Current operating spacecraft include: Cluster II, AIM, ACE, THEMIS, Voyager, Wind, Geotail, TWINS, RHESSI, CINDI, STEREO, SOHO, TIMED, Hinode, and SDO (to launch in 2009). It is this collective asset that provides the data, expertise, and research results that contribute directly to the national goal of real-time space weather prediction and to fundamental research on solar and space plasma physics. In 2008, these missions underwent their biannual Senior Review from which new budgets have been recommended, consistent with their evolving scientific goals. Major decisions based on the Senior Review findings included the termination of the FAST mission, approval to proceed with the Artemis mission (a splitting of two of the high-orbit satellites in the THEMIS constellation to lunar orbits), as well as continuing with the THEMIS-Low mission.

The Space Physics Data Facility (SPDF) leads in the design and implementation of unique multi-mission and multi-disciplinary data services, innovative ground data system concepts, educational programs, and cross-cutting data, modeling and visualization research. NASA's Solar Data Analysis Center provides a variety of routes to current and past solar images and digital data. Links on the home page (http://umbra.nascom.nasa.gov) will bring you up-to-date on the current state of the Sun and its surrounding atmosphere.

The Heliophysics Guest Investigator Program (GIP) is a critical component of the Heliophysics Operating Missions. The GIP program selects the best ideas from a broad community of researchers in universities and institutions across the country, enabling optimum science return through utilization of data from the operating missions. This year all Heliophysics Education efforts will be consolidated under this project and competed via the Research Opportunities in Space and Earth Science (ROSES) announcement in order to better coordinate program and mission activities. NASA will select education and outreach proposals that best explain and inspire students and the public on the science of Heliophysics and the societal impacts of space weather.

Science Data and Computing: Science Data and Computing includes two elements, the National Space Science Data Center (NSSDC) and administration of the Applied Information Systems Research (AISR) investigations selected under the ROSES NASA Research Announcements (NRA). Both are SMD-wide support activities. The NSSDC is responsible for assuring the permanent archiving and preservation of space science data from past missions. The AISR Program exploits advances in information science and technology to enhance the science productivity from SMD-sponsored missions.

Science Planning & Research Support: This project funds scientists to be on peer review panels and other community science support efforts (e.g., strategic road mapping, support to NRC boards, interagency working groups, SMD advisory groups and other reviews as requested by SMD).

GSFC Building Support: The Exploration Sciences building, currently under construction at the Goddard Space Flight Center, is a 262,500 square-foot laboratory and office building. The facility will provide state-of-the-art laboratory, support, and office space for 750 scientists. By consolidating science work groups, it is expected to increase work efficiency and scientific collaboration. The new facility will replace the 44-year old Research Projects Laboratory building and the 37-year old Space Science Data Center building.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Annual peer-reviewed research solicitation for grant opportunities	Research & Analysis	None

Implementation Schedule

Project	Schedule by Fiscal Year																Phase Dates		
	Prior	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22		Beg	End
Voyager																	Tech Form Dev Ops Res	Aug-77	Aug-13 Aug-14
Geotail																	Tech Form Dev Ops Res	Jul-92	Jul-08 Jul-10
Wind																	Tech Form Dev Ops Res	Nov-94	Nov-13 Nov-14
Solar and Heliospheric Observatory (SOHO)																	Tech Form Dev Ops Res	Dec-95	Dec-13 Dec-14
Advanced Composition Explorer (ACE)																	Tech Form Dev Ops Res	Aug-97	Aug-13 Aug-14
Cluster-II																	Tech Form Dev Ops Res	Jul-00	Jul-10 Jul-11
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)																	Tech Form Dev Ops Res	Dec-01	Dec-13 Dec-14
RHESSI																	Tech Form Dev Ops Res	Feb-02	Feb-13 Feb-14

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Program Management

NASA Headquarters has program management resonsiblity for the Heliophysics Research Program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research and Analysis	SMD	All NASA Centers	None
Heliophysics Operating Missions	SMD	GSFC and JPL	ESA and JAXA
Sounding Rockets and Research Range	SMD	GSFC	None
Science Data and Computing	SMD	GSFC and other NASA Centers	None

Acquisition Strategy

All acquisitions in the Heliophysics Research and Analysis (R&A) component are based on full and open competition. Proposals are peer reviewed and selected based on the NASA research announcement, Research Opportunities in Space and Earth Sciences (ROSES). Universities, government research labs, and industry throughout the U.S. participate in R&A research projects. The Heliophysics Operating Missions and instrument teams were previously selected from NASA Announcements of Opportunity. NASA evaluates the allocation of funding among the operating missions bi-annually through the Heliophysics Senior Review.

Both the prime contracts for the Sounding Rocket Operations and for Research Range Operations are currently being re-competed. The new contracts are expected to be in place by late 2009.

The Science Data and Computing component holds a competition where proposals are peer reviewed and selected based on ROSES research announcement. Universities, government research labs, and industry throughout the United States participate in Science Data and Computing Technology research projects.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	N/A	The Heliophysics data centers along with the NSSDC will undergo a Senior Review panel in July 2009 to assess their operational effectiveness.	07/2009

THIS PAGE INTENTIONALLY BLANK

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	218.1	238.6	212.2	204.6	208.7	230.0	236.6
Solar Dynamics Observatory (SDO)	108.1	20.8	34.1	20.2	18.6	16.3	15.6
Radiation Belt Storm Probes (RBSP)	67.8	154.4	137.1	127.9	105.1	22.0	17.3
Solar Probe Plus	13.9	18.0	4.0	16.6	36.7	57.8	81.3
Other Missions and Data Analysis	28.4	45.3	37.0	39.8	48.3	134.0	122.4
FY 2009 President's Budget Request	217.1	223.8	212.0	216.6	232.8	237.5	--
Solar Dynamics Observatory (SDO)	90.0	24.1	14.2	14.0	14.9	14.1	--
Radiation Belt Storm Probes (RBSP)	77.7	154.4	154.7	113.4	57.9	15.8	--
Solar Probe Plus	13.9	0.0	3.4	40.1	74.2	106.3	--
Other Missions and Data Analysis	35.5	45.3	39.7	49.2	85.8	101.3	--
Changes from FY 2009 Request	1.0	14.7	0.2	-11.9	-24.1	-7.5	--

Note: SDO budget increased to accommodate launch delay. RBSP budget rephased consistent with budget approved at Confirmation Review. Solar Probe Plus budget is consistent with a 2018 launch date.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Overview

The Living with a Star (LWS) Program seeks to improve our understanding of how and why the Sun varies, how the Earth and solar system respond, and most importantly, how this variability and response affect life on Earth. This improved understanding of solar variability (i.e., space weather) and its effects will lead to a reliable predictive capability for space weather. This capability is essential to safe and successful future space exploration and increased use of complex technological systems to improve the safety and quality of life on the ground. LWS accomplishes its goals with a combination of new science missions and yearly science research grant opportunities. Its first mission, the Solar Dynamics Observatory (SDO), will complement and improve upon major capabilities of the Solar and Helispheric Observatory (SOHO), launched in 1995.

Prof. James van Allen made the first major discovery of the space age with Explorer 1 in 1958: the existence of Earth's two radiation belts, which are now named after him. The second LWS mission, the Radiation Belt Storm Probes (RBSP), will analyze these phenomena in unprecedented detail. Two identical spacecraft in elliptical orbits will make simultaneous measurements of processes that accelerate and transport radiation particles as they transit through Earth's radiation belts. The RBSP results will enable the development of models for Earth's radiation belts and for other related but under-sampled planetary environments, such as Mars. Spacecraft and aeronautics engineers will apply the models to improve spacecraft design and to alert operators or pilots of predicted storms and ionizing radiation that could impact crew health or vehicle operations.

Two additional missions are currently developing mission concepts: the Solar Probe Plus (SPP) mission and Solar Orbiter Collaboration (SOC) with the European Space Agency. Solar Probe Plus will explore the Sun from very close range (inside 10 solar radii) to improve our understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. The SOC will investigate the links between the solar surface, corona, and inner heliosphere from as close as 45 solar radii and image the side of the Sun not visible from Earth.

For more information, please see http://lws.gsfc.nasa.gov/.

Plans For FY 2010

The Solar Dynamics Observatory will launch in November 2009. NASA plans to award instrument contracts for the Solar Probe Plus mission. Detailed design activities for the Solar Orbiter Collaboration with the European Space Agency will begin following the selection of the science instruments. The RBSP mission will continue fabrication and test activities and conduct the System Integration Review. The Space Environment Testbeds and BARREL projects will continue testing for their upcoming launches in 2013 and 2012 respectively.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Project Descriptions and Explanation of Changes

Solar Dynamics Observatory (SDO)

The Solar Dynamics Observatory (SDO) is currently in development. It will investigate how the Sun's magnetic field is structured, as well as how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance. The SDO mission will launch in October or November of 2009, a delay of 10 months from the previously planned launch date, due to problems securing a spot on the Atlas V launch vehicle manifest. Additional detail can be found in the SDO section of this document.

Radiation Belt Storm Probes (RBSP)

The RBSP mission will improve the understanding of how solar storms interact with and change particles, fields, and radiation in Earth's Van Allen radiation belts and atmosphere. This knowledge could be applied to any planet in our solar system that has a magnetic core. This mission was recently confirmed to proceed into the development phase and is scheduled to launch in May 2012. Additional detail can be found in the RBSP section of this document.

Solar Probe Plus

The Solar Probe Plus mission is currently in formulation. It will perform the first in-situ measurements very close to the Sun (as close as 10 solar radii) to improve our understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. NASA is examining several Solar Probe Plus mission architectures and technologies for the mission. Instruments will be selected in 2010 in support of a 2018 launch. Additional detail can be found in the Solar Probe Plus section of this document.

Other Missions and Data Analysis

Space Environment Testbeds (SET): The Space Environment Testbeds (SET) will improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design and operations. It has two components: a data mining element that has been completed and a space flight mission. The flight mission is a testbed that has been delivered to the U.S. Air Force for integration onto its Demonstration and Science Experiments (DSX) payload. The DSX launch is scheduled for 2013.

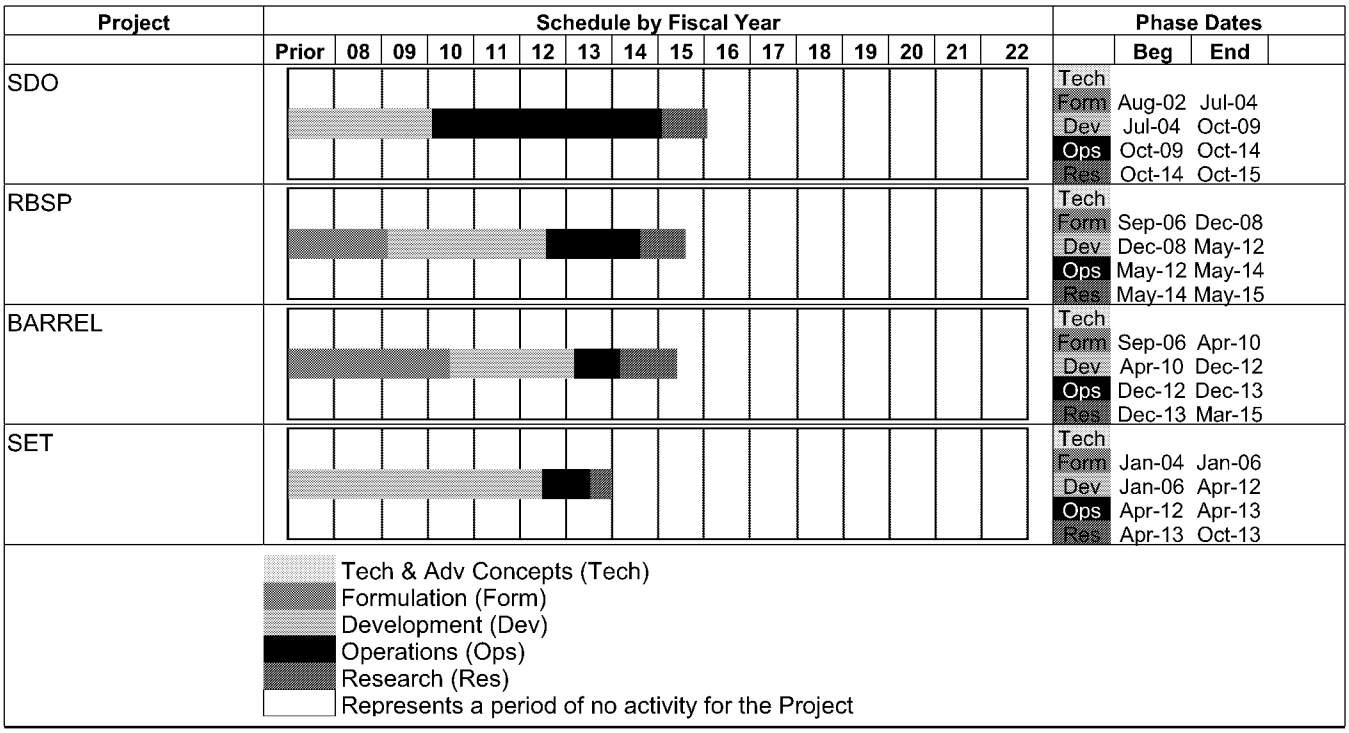
Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL): BARREL is a balloon-based mission that will launch a series of science instruments to complement the measurements made on the Radiation Belt Storm Probes (RBSP) mission. BARREL will measure the precipitation of relativistic electrons from the radiation belts. Implementation responsibility has been assigned to the Wallops Balloon Program Office.

Solar Orbiter Collaboration (SOC): The Solar Orbiter Collaboration (SOC) is a cost sharing mission with the European Space Agency (ESA) wherein ESA provides the spacecraft, the ESA member states provide most instrument/science investigations, and the LWS Program provides the launch vehicle and three instrument/science investigations. These instruments were selected in March 2009 and will continue formulation work in 2010. The SOC will provide close-up views of the Sun's polar regions and its back-side and will tune its orbit to the direction of the Sun's rotation. This will permit the spacecraft's instruments to observe emissions and solar wind from one specific area for much longer than currently possible and will provide more insight into the evolution of sunspots, active regions, coronal holes and other solar features and phenomenona than past missions.

Living with a Star Science: LWS science funds competitively-selected proposals that improve the understanding of the physics of the integrated system that links the Sun to the heliosphere and planetary atmospheres. This improved understanding will be achieved through data analysis to support the development of new or revised theories and models and is the precursor to a predictive space weather capability.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Implementation Schedule



Program Management

Goddard Space Flight Center (GSFC) is the managing center for the program. Missions are implemented by GSFC or Johns Hopkins University-Applied Physics Laboratory (JHU-APL).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
SDO	GSFC	GSFC	None
RBSP	JHU/APL	None	National Reconnaissance Office (NRO)
BARREL	GSFC	GSFC	None
Solar Probe Plus	JHU/APL	TBD	TBD
SOC	GSFC	TBD	TBD
SET	GSFC	GSFC	CNES (French Space Agency, Centre National d'Etudes Spatiales), DERA (Defence Evaluation and Research Agency)

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Acquisition Strategy

LWS missions will be managed either by Goddard Space Flight Center (GSFC) or by Johns Hopkins University - Applied Physics Laboratory (JHU-APL). All missions will report to GSFC as the managing center for the program. The Science Mission Directorate Associate Administrator will determine which organization will manage each mission, and whether the spacecraft will be procured or built in-house at the managing organization for the mission.

The SDO launch vehicle and two instruments were selected through full and open competition, and one instrument is being provided sole-source from the Lockheed Martin Corporation. The spacecraft is an in-house build at GSFC.

Four instrument suites for the Radiation Belt Storm Probes (RBSP) were selected through full and open competition, and one instrument was manifested at the request of the National Reconnaissance Office. The launch vehicle will be selected through full and open competition, and the spacecraft is an in-house build at JHU/APL.

BARREL was selected through full and open competition through the same solicitation as the RBSP instruments. Two SET experiments were selected through full and open competition, and two were contributed by CNES and DERA.

Solar Probe Plus will continue being studied in preparation for the selection of science investigations. NASA-led Solar Orbiter Collaboration (SOC) instruments are to be selected using full and open competition as will the Solar Probe Plus and SOC launch vehicles. No decision has been made regarding the acquisition of the Solar Probe spacecraft.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the LWS Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2011

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**619.1**	**108.1**	**20.8**	**34.1**	**20.2**	**18.6**	**16.3**	**15.6**	**17.2**	**870.0**
Formulation	84.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.9
Development / Implementation	534.2	108.1	20.8	21.9	0.0	0.0	0.0	0.0	0.0	685.0
Operations / Close-out	0.0	0.0	0.0	12.2	20.2	18.6	16.3	15.6	17.2	100.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**618.7**	**90.0**	**24.1**	**14.2**	**14.0**	**14.9**	**14.1**	**--**	**8.6**	**798.5**
Formulation	84.9	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	84.9
Development / Implementation	522.1	90.0	3.2	0.0	0.0	0.0	0.0	--	0.0	615.3
Operations / Close-out	0.0	0.0	20.9	14.2	14.0	14.9	14.1	--	8.6	86.7
Other	11.7	0.0	0.0	0.0	0.0	0.0	0.0	--	-0.1	11.6
Changes from FY 2009 Request	**0.4**	**18.1**	**-3.3**	**19.9**	**6.3**	**3.6**	**2.2**	**--**	**8.7**	**71.4**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Development / Implementation	12.1	18.1	17.6	21.9	0.0	0.0	0.0	--	0.0	69.7
Operations / Close-out	0.0	0.0	-20.9	-2.0	6.2	3.7	2.2	--	8.6	13.4
Other	-11.7	0.0	0.0	0.0	0.1	-0.1	0.0	--	0.1	-11.7

Note: The FY 2010 LCC number in the table above is overstated by $2.4M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of the FY 2009 Inital Operating Plan, the estimated SDO lifecycle cost will be $867.6M, and the estimated Development costs will be $682.6M.

Explanation of Project Changes

The SDO mission will launch in November of 2009, a delay of 11 months from the previously planned launch date, due to problems securing a spot on the Atlas V launch vehicle manifest. The delay resulted in a significant increase in Development costs. The operations budget has also been increased to reduce risk.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Purpose

The Solar Dynamics Observatory (SDO) is the first mission for the Living With a Star (LWS) Program. It will investigate how the Sun's magnetic field is structured and how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance. Scientists will analyze SDO data to improve the science needed for space weather predictions. The five-year prime life is designed to provide measurements over a substantial portion of the solar cycle.

SDO measures subsurface flows, photopheric magnetic fields, high-temperature solar atmospheric structures, and the extreme ultraviolet spectral irradiance that affects Earth's atmosphere. SDO plans to provide crucial understanding of solar activity, the solar cycle, and the inputs to geospace. Predictive modeling cannot improve without the improved data SDO will provide. SDO is an essential replacement for the aging SOHO spacecraft.

For more information please go to the website for SDO: http://nasascience.nasa.gov/missions/sdo.

Project Parameters

The SDO satellite will be placed into an inclined geosynchronous orbit to allow for a nearly-continuous observation of the Sun, a high-science data downlink rate, and contact with a single, dedicated, ground station. The combined data from the satellite and the three science instruments--the Helioseismic and Magnetic Imager (HMI), the Extreme Ultraviolet Variability Experiment (EVE), and the Atmospheric Imaging Assembly (AIA)--will require a downlink rate of 1.4 terrabytes per day.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Commitments

SDO will launch in November 2009 to begin a five-year prime mission in geosynchronous Earth orbit.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Helioseismic and Magnetic Imager (HMI)	Stanford University	Resolution of 1 arc-second, with noise level <= 40 meters per second and 25 Gauss respectively: obtain full-disk photospheric velocity and longitudinal magnetic field measurements every 60 seconds.	Same	Same
Atlas V Evolved Expendable Launch Vehicle (EELV)Vehicle	KSC and Lockheed Martin	Deliver a 3,200 kg spacecraft to geosynchronous transfer orbit at about 2,500 km altitude.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instrument to ground station with a high accuracy for 5 years.	Same	Same
Atmospheric Imaging Assembly (AIA)	Lockheed Martin Solar Astrophysics Laboratory	Field-of-view of 40 arc-minutes in 1 chromospheric, 3 coronal wavelength bands with 1.2 arc-second resolution, and a cadence of 4 images every 10s: obtain full-disk images of the solar atmosphere.	Same	Same
Extreme Ultraviolet Variability Experiment (EVE)	University of Colorado	Make hourly solar spectral irradiance measurements in 6 emission lines at resolution of 0.2 nanometers, and measure Helium II emission line with resolution of 5 nanometers.	Same	Same
Ground System	GSFC	Transmit 1.3 MB/sec of Ka-band science data to the scientists and have 30-day backup ground storage.	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Schedule Commitments

NASA authorized the Solar Dynamics Observatory (SDO) project to begin formulation in August 2002 and to enter phase B in October 2003. After an independent review coincident with the project's Preliminary Design Review, the NASA Program Management Council confirmed the SDO Project to begin development in July 2004.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Begin Implementation	July 2004	Same	Same
Critical Design Review	February 2005	April 2005	Same
Complete Spacecraft Structure	January 2006	March 2006	Same
Deliver Science Instruments to Spacecraft	February 2007	November 2007	Same
Launch Readiness	August 2008	December 2008	November 2009

Development Cost and Schedule Summary

Development costs have increased to accommodate the launch delay from December 2008 to November 2009.

Project	Base Year	Base Year Development Cost Estimate ($M)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Solar Dynamics Observatory (SDO)	2006	623.7	2009	682.6	9	Launch Readiness	8/30/2008	11/1/2009	14

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**623.7**	**682.6**	**58.9**
Spacecraft	234.1	147.8	-86.3
Payload	181.8	152.4	-29.4
I & T	0.0	5.4	5.4
Launch Vehicle	120.6	108.3	-12.3
Ground System	69.7	44.7	-25.0
Science / Technology	0.0	0.0	0.0
Other	17.5	210.9	193.4
Reserve	0.0	13.1	13.1

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Management

The spacecraft has been built in-house at Goddard Space Flight Center (GSFC). GSFC is also responsible for management, design, integration, test, and operations. The Heliophysics Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Helioseimic and Magnetic Imager (HMI)	GSFC	None	None
EELV	KSC	KSC	None
Spacecraft design, integration, and test	GSFC	GSFC	None
Atmospheric Imaging Assembly (AIA)	GSFC	None	None
Extreme Ultraviolet Variability Experiment (EVE)	GSFC	None	None
Mission Operations	GSFC	GSFC	None

Acquisition Strategy

All major acquisitions are currently in place. The SDO spacecraft and ground system have been designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local task contractors. The SDO project procurement office sub-contracted for spacecraft sub-assemblies, components and parts. The ground system components include a dedicated ground station antenna/facility and science data distribution system at White Sands, New Mexico, and a mission operations center at GSFC. The EVE and HMI science investigations were procured through the Announcement of Opportunity (AO) process. NASA acquired the AIA instrument through a sole-source contract on an emergency basis after the original provider was unable to demonstrate readiness to enter Phase B.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	09/2008	Assess project status on cost and schedule. Project was approved to proceed with rebaselining to new launch date of November 2009 with associated cost increase.	09/2009

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Operations in Radiation Environment	Mission lifetime and reliability may be limited due to the severe ionizing radiation environment in geosynchronous Earth orbit (GEO).	Develop and verify requirements for operation that begin at the materials and component levels and continue through the level of the entire observatory. Liklihood of risk: possible, but not likely.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**49.0**	**67.8**	**154.4**	**137.1**	**127.9**	**105.1**	**22.0**	**17.3**	**5.2**	**685.8**
Formulation	49.0	39.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	88.2
Development / Implementation	0.0	28.8	154.2	137.1	127.9	85.9	0.0	0.0	0.0	533.9
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	19.2	22.0	17.3	5.2	63.7
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**49.0**	**77.7**	**154.4**	**154.7**	**113.4**	**57.9**	**15.8**	**--**	**0.0**	**622.9**
Formulation	49.0	77.1	20.3	0.0	0.0	0.0	0.0	--	0.0	146.4
Development / Implementation	0.0	0.6	134.1	154.7	113.4	20.9	0.0	--	0.0	423.7
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	37.0	15.8	--	0.0	52.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Changes from FY 2009 Request	**0.0**	**-9.9**	**0.0**	**-17.6**	**14.5**	**47.2**	**6.2**	**--**	**5.2**	**63.0**
Formulation	0.0	-38.1	-20.1	0.0	0.0	0.0	0.0	--	0.0	-58.2
Development / Implementation	0.0	28.2	20.1	-17.6	14.5	65.0	0.0	--	0.0	110.2
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	-17.8	6.2	--	5.2	10.9
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.1

Explanation of Project Changes

RBSP was recently confirmed to proceed into the development phase, and will now launch in May 2012. In confirming the project, NASA added 7 months and $52M to the project's schedule and cost to ensure the project entered development at a 70% cost and schedule confidence level.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Purpose

The Radiation Belt Storm Probes (RBSP) mission will observe the fundamental processes that energize and transport radiation particles in Earth's inner magnetosphere (the area in and around the Earth's radiation belts). These dynamic processes operate throughout the universe at other planets and stars, and they continuously operate within Earth's immediate space environment.

The primary science objective of the RBSP mission is to provide understanding, ideally to the point of predictability, of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun. The RBSP mission lifetime will provide sufficient local time, altitude, and event coverage to improve our understanding, and determine the relative significance of the various mechanisms that operate within the radiation belts.

RBSP observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace. It is also very important that we understand the space weather in geospace as we resume human exploration because it can impact the many US space assets that play a role in our national security and support human exploration.

Project Parameters

The RBSP mission is comprised of two identical spacecraft in elliptical, low-inclination orbits that travel independently through Earth's radiation belts to distinguish time and space variations in the measured ions, electrons, and fields.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Commitments

The Radiation Belt Storm Probes (RBSP) project will launch two identical spacecraft in 2012 to begin a two-year prime mission.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
EELV	KSC	Deliver a spacecraft to operational orbit	Same	Same
Energetic Particle, Composition and Thermal Plasma Suite (ECT)	Boston University	Measure the electron & ion spectra & composition to understand the electron & ion changes	Same	Same
Radiation Belt Storm Probes Ion Composition Experiment (RBSPICE)	New Jersey Institute of Technology	Measure the ring current in the magnetosphere during geomagnetic storms	Same	Same
Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS)	University of Iowa	Measure the magnetic fields & plasma waves	Same	Same
Electric Field and Waves Instrument for the NASA RBSP Mission (EFW)	University of Minnesota	Measure the electric fields in the radiation belts	Same	Same
Proton Spectrometer Belt Research (PSBR)	National Reconnaissance Office	Measure the inner Van Allen belt protons	Same	Same
Spacecraft	JHU-APL	Operate science instruments in high radiation; transmit science data to ground	Same	Same
Ground System	Primary ground station at JHU/APL; instrument operation is distributed among investigators	Receive science data from two spacecraft; distribute to archive	Same	Same

Schedule Commitments

The RBSP project was authorized to begin formulation in September 2006 when the selections for science investigations were announced. It was confirmed to proceed into development on December 19, 2008. Schedule details are still under development and are subject to change.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Begin Implementation	January 2009	N/A	January 2009
Critical Design Review	December 2009	N/A	December 2009
System Integration Review	November 2010	N/A	November 2010
Launch Readiness Review	May 2012	N/A	May 2012

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Radiation Belt Storm Probes (RBSP)	2009	533.9	2009	533.9	0	Launch Readiness	5/31/2012	5/31/2012	0

Development Cost Details

Development cost details are still under work by the project and are subject to change.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**533.9**	**533.9**	**0.0**
Spacecraft	85.6	85.6	0.0
Payload	95.4	95.4	0.0
System I&T	36.9	36.9	0.0
Launch Vehicle	133.6	133.6	0.0
Ground System	16.3	16.3	0.0
Science/Technology	3.1	3.1	0.0
Other	163.0	163.0	0.0

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Management

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Ground Systems	APL	None	None
Data Analysis	APL	None	National Reconnaissance Office
Instrument Development	APL	None	National Reconnaissance Office
Spacecraft design, integration with instrument, and test	APL	None	None
Mission Operations	APL	None	None
Expendable Launch Vehicle	KSC	TBD	None

Acquisition Strategy

The RBSP spacecraft and ground system are being designed, developed, and tested at the JHU-APL. The acquisition of sub-contracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the JHU-APL Procurement Office. Instrument development participants include the University of Iowa, University of Minnesota, New Jersey Institute of Technology, and Boston University, as well as contributions from the National Reconnaissance Office and the Czech Republic.

The ground system components were defined during the formulation phases (Phases A and B) and include a mission operations center at the JHU-APL.

The Energetic Particle, Composition and Thermal Plasma Suite (ECT), Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS), Electric Field and Waves Instrument for the NASA RBSP Mission (EFW), and Radiation Belt Storm Probeslons Composition Experiment (RBSPICE) science investigations were procured through the Announcement of Opportunity process. The Proton Spectrometer Belt Research (PSBR) instrument is being contributed through an agreement with the National Reconnaissance Office.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board	10/2008	Preliminary Design Review. Review concluded that the RBSP design was sufficiently mature to proceed to KDP-C.	12/2009

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	13.9	18.0	4.0	16.6	36.7	57.8	81.3
FY 2009 President's Budget Request	13.9	0.0	3.4	40.1	74.2	106.3	--
Total Change from 2009 President's Budget Request	0.0	18.0	0.7	-23.4	-37.6	-48.6	--

Project Purpose

Solar Probe Plus will be an extraordinary and historic mission, exploring the Sun's outer atmosphere, or corona, as it extends out into space. Approaching as close as 9.5 solar radii, Solar Probe Plus will repeatedly sample the near-Sun environment, revolutionizing our knowledge and understanding of coronal heating and of the origin and evolution of the solar wind, answering critical questions in heliophysics that have been ranked as top priorities for decades. Moreover, by making direct, in-situ measurements of the region where some of the most hazardous solar energetic particles are energized, Solar Probe Plus will make a fundamental contribution to our ability to characterize and forecast the radiation environment in which future space explorers will work and live.

For more information please see Solar Probe project at:
http://nasascience.nasa.gov/missions/solar_probe.

Project Preliminary Parameters

The first near-Sun pass occurs three months after launch, at a heliocentric distance of 35 RS (Solar Radius). Over the next several years successive Venus gravity assist maneuvers gradually lower the spacecraft's near-Sun pass to approximately 9.5 RS, by far the closest any spacecraft has ever come to the Sun. With an August 2018 launch, Solar Probe Plus will spend, during its seven year mission, a total of 30 hours inside 10 RS, 961 hours inside 20 RS, and 2149 hours inside 30 RS, sampling the solar wind as it evolves with rising solar activity toward an increasingly complex structure.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Estimated Project Deliverables

Solar Probe will launch from KSC on an EELV in 2018, with an expected mission duration of 7 years.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
EELV	KSC	Deliver the spacecraft to operational orbit	N/A	Same
Ground Systems	TBD	Receive science data and telemetry from spacecraft, command spacecraft, distribute science data to investigator teams	N/A	Same
Spacecraft	TBD	Transport instruments to science destination, operate instruments, modify orbit including several Venus gravity	N/A	Same
Instruments	NASA-funded investigators	Perform in situ measurements and remote observations of the Sun	N/A	Same

Estimated Project Schedule

The release of Solar Probe Announcement of Opportunity to solicit science investigations occurs in April/May 2009. NASA anticipates announcing selections in the Fall of 2009 and beginning formulation then. Phase B will begin in December 2012 following a successful preliminary Non-Advocate Review (PNAR).

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Mission Definition Review	04/2012	N/A	04/2012
Initial Confirmation Review	09/2012	N/A	09/2012
Confirmation Review	03/2014	N/A	03/2014
Launch	08/2018	N/A	08/2018

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Project Management

Johns Hopkins University/Applied Physics Laboratory (JHU/APL) will lead the implementation of the project. GSFC is responsible for oversight and science management including data analysis during opeations.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instrument	GSFC	TBD	None
EELV	GSFC	KSC	None
Spacecraft	TBD	TBD	None
Mission Operations	GSFC	GSFC	None

Acquisition Strategy

A Solar Probe Announcement of Opportunity will be used to acquire the science investigations. The acquisition strategy for the spacecraft itself will be determined later in 2009. The spacecraft sub-assemblies, components, and parts will be procured by JHU-APL. The ground system components will be defined during formulation and will be determined by the implementing organization for the project. The Phase E contracts will be managed by GSFC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	Assess project readiness to proceed to Phase B.	07/2012

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	71.9	123.1	143.0	169.1	170.6	160.8	164.3
Magnetospheric Multiscale (MMS)	43.1	94.6	118.6	149.3	148.8	137.5	143.8
Other Missions and Data Analysis	28.8	28.5	24.4	19.8	21.8	23.3	20.5
FY 2009 President's Budget Request	105.9	123.1	137.5	171.4	172.6	161.5	--
Magnetospheric Multiscale (MMS)	73.2	94.6	116.0	149.3	148.8	137.5	--
Other Missions and Data Analysis	32.7	28.5	21.5	22.0	23.9	24.1	--
Changes from FY 2009 Request	-34.0	0.0	5.5	-2.2	-2.0	-0.7	--

Note: Extended operations budgets increased for STEREO and Hinode missions. MMS budget increased to accommodate higher than expected launch vehicle costs.

Program Overview

The primary goal of the Solar Terrestrial Probes (STP) Program is to explore the connection between the Sun and the solar system. To accomplish this goal, STP investigations focus on specific scientific areas that will help us understand how plasma behaves in the space between the Sun and Earth. STP missions address processes such as the variability of the Sun, the responses of the planets to these variations, and the interaction of the Sun and solar system. STP missions are strategically defined and investigations are competitively selected. Strategic mission lines afford the space physics community the opportunity to plan specific missions to address important research focus areas and thus make significant progress in elucidating the fundamental processes of Heliophysics.

For more information please see Solar Terrestrial Probes Program at: http://stp.gsfc.nasa.gov/.

Plans For FY 2010

The Magnetospheric Multiscale Mission will complete its mission Critical Design Review (CDR). The Hinode Mission will complete its mission success criteria. The STEREO mission will commence joint observations with SDO.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Project Descriptions and Explanation of Changes

Magnetospheric Multiscale (MMS)

MMS is a four-spacecraft mission planned for launch no earlier than 2014 with a two-year mission life. MMS is designed to study magnetic reconnection in key boundary regions of the Earth's magnetosphere. Reconnection is a fundamental process that occurs throughout the universe, by which magnetic energy is converted into heat, radiation, and particle acceleration. The best laboratory for understanding this process is the Earth's magnetosphere, where reconnection between the Earth's and Sun's magnetic fields powers magnetic storms and substorms on our planet, otherwise known as "space weather." The spacecraft will probe the regions of geospace most critical to measuring reconnection. Additional detail can be found in the Magnetospheric Multiscale Project section of this document.

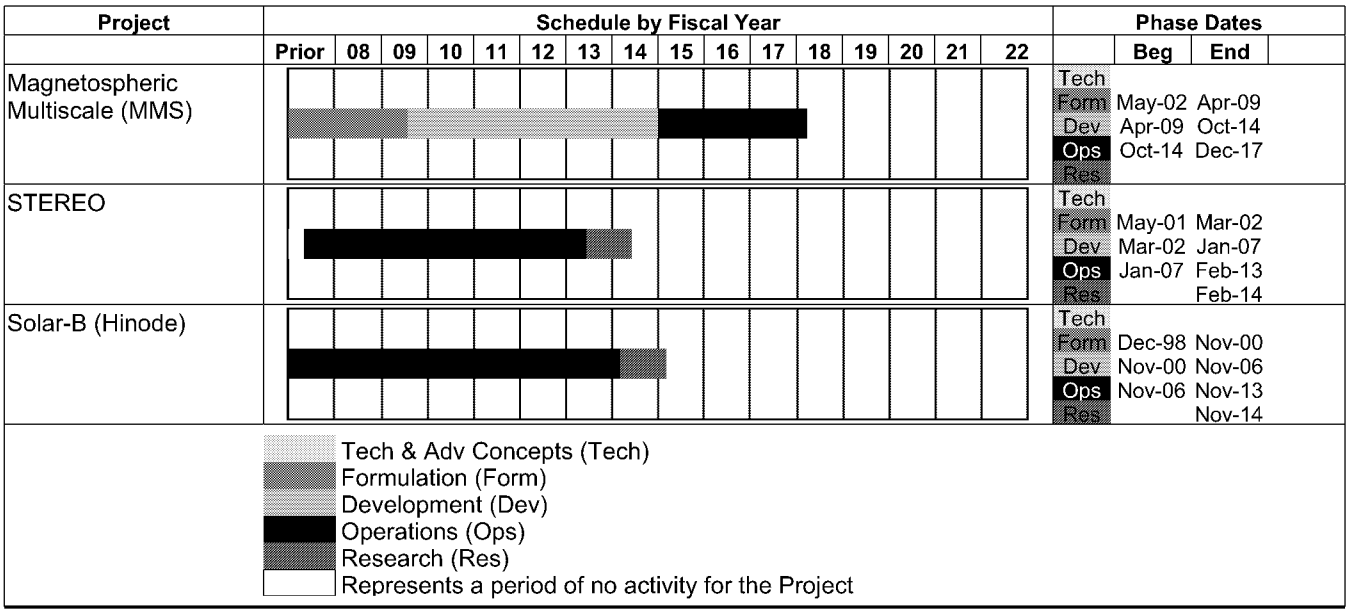
Other Missions and Data Analysis

Solar TErrestrial RElations Observatory (STEREO): Launched on October 25, 2006, STEREO is now an operating mission employing two nearly identical observatories to provide three-dimensional measurements of the Sun to study the nature of coronal mass ejections. These powerful eruptions are a major source of the magnetic disruptions on Earth and a key component of space weather, which can greatly affect satellite operations, communications, power systems, the lives of humans in space, and global climate.

Solar B (Hinode): Hinode launched on September 22, 2006, from Japan's Uchinoura Space Center to begin its three-year mission to explore the magnetic fields of the Sun. NASA developed three science instrument components: the Focal Plane Package (FPP), the X-Ray Telescope (XRT), and the Extreme Ultraviolet Imaging Spectrometer (EIS) and provides operations support for science planning and instrument command generation activities. A follow-on to the highly successful Japan/US/UK Yohkoh (Solar-A) satellite that operated between 1991 and 2001, Hinode consists of a coordinated set of optical, Extreme-Ultraviolet (EUV), and X-ray instruments that will investigate the interaction between the Sun's magnetic field and its corona. The result will be an improved understanding of the mechanisms that power the solar atmosphere and drive solar eruptions.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Implementation Schedule



Program Management

Program management responsibility for the STP Program is assigned to the Goddard Space Flight Center (GSFC).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MMS	GSFC	GSFC	Austria, Sweden, France
Solar B (Hinode)	MSFC	MSFC	JAXA
STEREO	GSFC	None	United Kingdom

Acquisition Strategy

STP missions are strategically defined and investigations are competitively selected. The STP uses full and open competitions to the greatest extent possible for the acquisition of scientific instruments, spacecraft, and science investigations, including research and analysis.
The MMS spacecraft and Mission Operations Center will be in-house builds at GSFC. The Southwest Research Institute (SwRI) is the single MMS instrument suite contractor, selected through a full and open competition. All instruments are developed by the SwRI team which includes SwRI, their subcontractors, their international partners, and the GSFC Fast Plasma Instrument.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the STP Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2011

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	43.1	94.6	118.6	149.3	148.8	137.5	143.8
FY 2009 President's Budget Request	73.2	94.6	116.0	149.3	148.8	137.5	--
Total Change from 2009 President's Budget Request	-30.1	0.0	2.6	0.0	0.0	0.0	--

Project Purpose

The Magnetospheric Multiscale (MMS) Project will use four identically instrumented spacecraft to perform the first definitive study of magnetic reconnection in space. Reconnection occurs in all astrophysical plasma systems but can be studied efficiently only in the Earth's magnetosphere. It is thought to be of great importance for energy transfer throughout the universe and is an efficient and fast acceleration mechanism. Reconnection is the primary process by which energy is transferred from the solar wind to Earth's magnetosphere and is the critical physical process determining the size of a space weather geomagnetic storm. MMS will determine why magnetic reconnection occurs, where it occurs, how it varies, how magnetic energy is coupled into heat and particle kinetic energy, and how this energy is coupled into the surrounding plasma.

MMS results will be needed as soon as possible as a basis for the predictive models of space weather needed to undertake heliospheric weather prediction in support of Exploration. Magnetic reconnection is a primary source of energy release and particle acceleration in plasmas. No mission has ever been properly instrumented and configured to measure the small-scale features of reconnection in space. For more information see: http://stp.gsfc.nasa.gov/missions/mms/mms.htm.

Project Preliminary Parameters

The MMS instrument payload will measure electric and magnetic fields and plasmas within the small-scale diffusion regions where magnetic reconnection occurs. High temporal and spatial resolution measurements will permit direct observation of the microphysical processes that allow it to proceed. The four spacecraft and instrument suites have identical design requirements. A two-phase, low-inclination orbit will probe both the dayside magnetopause and the nightside magnetotail neutral sheet where reconnection is known to frequently occur. The primary target of Phase 1 is the dayside magnetopause reconnection region. Phase 2 will focus on the near-Earth neutral line in the magnetotail. The four spacecraft will fly in a tetrahedron formation and the separation between the observatories will be adjustable over a range of 10 to 400 kilometers during science operations and within the area of interest. The mission design life is two years after spacecraft checkout and full commissioning of the instruments.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Estimated Project Deliverables

NASA plans to launch four identically-instrumented spacecraft on an Evolved Expendable Launch Vehicle (EELV) into a highly elliptical Earth orbit in October 2014 and begin two years of scientific measurements that will enable an understanding of fundamental plasma physics processes associated with magnetic reconnection.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Launch Vehicle	KSC	Deliver ~4,000-kg payload consisting of 4 observatories to a highly elliptical Earth orbit	Same	Same
Ground Systems	GSFC	Provide during operations minimum science data payback of ~4 Gbits of data per observatory each day.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instruments to ground station with a high accuracy for 2 years	Same	Same
Electric Field Instruments	Southwest Research Institute	Provide measurements of electric fields (time resolution 1 ms) and magnetic fields (time resolution 10 ms)	Same	Same
Fast Plasma Investigation	GSFC	Provide plasma wave measurements (electric vector to 100 KHz).	Same	Same
Energetic Particle Detectors	JHU/APL	Provide high-resolution measurement of energetic particles	Same	Same
Hot Plasma Composition Analyzers	Southwest Research Institute	Three-dimensional measurements of hot plasma composition (time resolution 10s).	Same	Same
Science Operations Center	LASP	Science data to the community and archive	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Estimated Project Schedule

Magnetospheric Multiscale (MMS) began formulation in 2002 and the project's Initial Confirmation Review was held in November 2007 and approved. The Non-Advocate and Confirmation Reviews are planned for 2009.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Mission Definition Review	September 2007	Same	Same
Initial Confirmation Review	November 2007	Same	Same
Confirmation Review	April 2009	April 2009	June 2009
Launch	October 2014	Same	Same

Project Management

The Goddard Space Flight Center (GSFC) has program management responsibility for the Solar Terrestrial Probes Program and Project Management responsibility for the MMS project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Four Instrument Suites	GSFC, Southwest Research Institute	GSFC	Austrian Space Agency, Sweden (SNSB), France (CNES), and Japan (JAXA)
Launch Vehicle	KSC	KSC	None
Four Spacecraft	GSFC	GSFC	None
Mission Operations	GSFC	GSFC	None
Science Operations	GSFC, LASP	None	None

Acquisition Strategy

The MMS spacecraft is being designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local support service contractors. The acquisition of subcontracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the MMS Procurement office. Instrument development activities are under contract with the Southwest Research Institute (SwRI). Instrument development subcontracts include Lockheed Martin, JAXA/MEISEI, University of New Hampshire, Johns Hopkins University/Applied Physics Laboratory, Aerospace Corporation, and a team at GSFC. The Mission Operations Center and the Flight Dynamics Operations Area will be developed and operated at GSFC using a combination of GSFC civil servants and local support service contractors. The Science Operations Center for the Instruments will be developed and operated at the Laboratory for Atmospheric and Space Physics at the University of Colorado and is under contract to SwRI.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	09/2007	To assess MMS readiness to proceed into Phase B. MMS was approved to enter Phase B.	05/2009

THIS PAGE INTENTIONALLY BLANK

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	48.1	31.4	69.4	119.7	158.1	161.3	167.4
GOLD	0.3	0.5	0.5	10.6	10.9	6.7	0.9
Other Missions and Data Analysis	47.9	30.9	68.9	109.1	147.2	154.6	166.5
FY 2009 President's Budget Request	61.0	41.3	66.8	125.1	156.0	160.1	--
Other Missions and Data Analysis	61.0	41.3	66.8	125.1	156.0	160.1	--
Changes from FY 2009 Request	-12.9	-9.9	2.6	-5.4	2.1	1.2	--

Note: FY 2010 President's Budget Request is overstated by $9.9M due to the transfer of Astro-H from Heliophysics Explorer to Astrophysics Explorer Program in FY 2010.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Overview

The Heliophysics Explorer Program provides frequent flight opportunities for world-class astrophysics and space physics investigations using innovative and streamlined management approaches for spacecraft development and operations.

Explorer missions are highly responsive to new knowledge, new technology, and updated scientific priorities by launching smaller missions that can be conceived and executed in a relatively short development cycle. Priorities are based on an open competition of concepts solicited from the scientific community. The program also enables participation in missions of opportunity provided by other U.S. or international agencies. The program emphasizes missions that can be accomplished under the control of the scientific research community within constrained mission life-cycle costs. The program also seeks to enhance public awareness of space science by incorporating educational and public outreach activities into each mission.

All investigations are competitively selected. Full missions can either be Medium-Class Explorers (MIDEX) or Small Explorers (SMEX). Mission of Opportunity (MO) space science investigations are typically instruments flown as part of a non-NASA space mission. MOs are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission.

Following the commissioning and checkout phase of the spacecraft, HQ management responsibility for the operational phase transitions to the Heliophysics Research Program. While the Research Program assumes management responsibilities, funds for operating missions is provided by the Explorer Program.

The Heliophysics Explorer Program is currently conducting a SMEX Announcement of Opportunity (AO) selection competition and expects to select 2 missions to proceed into full development during 2009. The Explorer Program is also considering selecting a second MO during 2009. One MO was previously selected under the same SMEX AO competition: the High-Resolution Soft X-Ray Spectrometer (SXS). SXS is an instrument that will fly on board the ASTRO-H X-ray observation satellite under development by the Japan Aerospace Exploration Agency (JAXA). The SXS investigation is an Astrophysics mission and its budget and management responsibility have been transferred to the Astrophysics Division.

The Interstellar Boundary Explorer (IBEX) launched in October 2008 is now operating. The Coupled Ion Neutral Dynamics Investigation (CINDI), and Two Wide-angle Imaging Neutral-atom Spectrometers B (TWINS-B) instruments also launched in 2008 and are conducting prime science operations. Two Explorer missions are currently in development in the Astrophysics Division: the Widefield Infrared Survey Explorer (WISE) and the Nuclear Spectroscopic Telescope Array (NuSTAR). Details and the associated budget can be found in the Astrophysics section of this document.

For more information, please see Explorer Program at http://explorers.gsfc.nasa.gov/missions.html

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Plans For FY 2010

The newly selected SMEX missions will progress towards their development phase. The THEMIS and IBEX missions will complete their mission success criteria. THEMIS will continue to provide scientists with important details on how the planet's magnetosphere works and the important Sun-Earth connection. IBEX will continue its primary science mission of mapping the heliosphere and uncovering the global interaction between the solar wind and the interstellar medium, producing its first all-sky map in 2010. TWINS-B and CINDI will both enter their second year on orbit. AIM will complete its primary mission to study Polar Mesospheric Clouds.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Project Descriptions and Explanation of Changes

Global-scale Observations of the Limb and Disk (GOLD)

GOLD is a recently selected mission of opportunity, implemented by Principal Investigator at the University of Central Florida, Orlando, Fla. GOLD will increase our understanding of the temperature and composition in the ionosphere, and provide understanding of the global scale response of the Earth's thermosphere and ionosphere. GOLD was conditionally selected under the most recent Explorer AO, and will be reviewed in 2009 to determine if it will continue into development.

GOLD will advance the general current scientific understanding of Thermosphere-Ionosphere forcing by providing neutral densities and temperatures in the thermosphere as well as densities in the nighttime ionosphere. GOLD will provide the first large-scale "snapshot" of temperature that can be compared with a simultaneous "snapshot" of composition changes to understand how these two major parameters simultaneously react to this these various forcing mechanisms. The relationship between universal time, local time and longitudinal changes in these key parameters can be unambiguously separated by the GOLD observations to enable us to address these interactions.

Other Missions and Data Analysis

Aeronomy of Ice in Mesophere (AIM): The primary objective of the AIM mission is to understand why polar mesospheric clouds (PMCs) form and why they vary. AIM will also determine the causes of Earth's highest-altitude clouds, which form in the coldest part of the atmosphere about 50 miles above the polar regions every summer. AIM launched on April 25, 2007, on board a Pegasus XL from Vanderberg Air Force Base. Hampton University will maintain operations for two years. This mission is supplying spectacular data which is leading to new science discoveries.

Coupled Ion-Neutral Dynamics Investigation (CINDI): CINDI is a NASA-sponsored Mission of Opportunity (MO) conducted by the University of Texas at Dallas (UTD). CINDI will discover the role of ion-neutral interactions in the generation of small- and large-scale electric fields in Earth's upper atmosphere. In addition, the CINDI instruments will provide measurements of the three-dimensional neutral winds and ion drifts. CINDI will operate for at least two years. This mission launched April 16, 2008, aboard the Air Force Research Laboratory's Communication/Navigation Outage Forecast System (C/NOFS) spacecraft. Early discoveries have been reported at the American Geophysical Union 2008 Fall Meeting.

Interstellar Boundary Explorer (IBEX): IBEX will allow the first glimpse into the edge of the solar system, where the solar wind interacts with winds from other stars. This region is a breeding ground for anomalous cosmic rays that form a component of energetic particles from beyond the solar system that pose health and safety hazards for humans exploring beyond Earth's orbit. As the solar wind from the Sun flows out beyond Pluto, it collides with the material between the stars, forming a shock front. IBEX contains two neutral atom imagers that are designed to detect particles from the so -called termination shock at the boundary between the solar system and interstellar space. IBEX will make these observations from an elliptical Earth orbit that takes it beyond the interference of Earth's magnetosphere. IBEX launched on October 5, 2008, on a Pegasus XL from Kwajalein. Southwest Research Institute will maintain operations for two years.

Time History of Events and Macroscale Interactions during Substorms (THEMIS): THEMIS has provided breakthroughs in our understanding of the onset and evolution of magnetospheric substorms. NASA's THEMIS mission uses five identical micro-spacecraft (probes) to answer the fundamental questions regarding magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within geospace. In addition to addressing its primary objective, THEMIS answers critical questions in radiation belt physics and solar wind-magnetosphere energy coupling. THEMIS is a Medium-Class Explorers (MIDEX) mission that launched on February 17, 2007, from Cape Canaveral, Florida, on board a Delta II rocket. The University of California, Berkeley maintains operations of the five satellites.

Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS-B): TWINS-B will provide the second half of the stereo imaging capability of Earth's magnetosphere in conjunction with the TWINS-A mission. The region surrounding the planet is controlled by its magnetic field and contains the Van Allen radiation belts and other energetic charged particles. TWINS-B will enable three-dimensional global visualization of this region, which will lead to a greatly enhanced understanding of the connections between different regions of the magnetosphere and their relation to the solar wind. TWINS-B was launched as a NASA-sponsored Mission of Opportunity in February 2008.

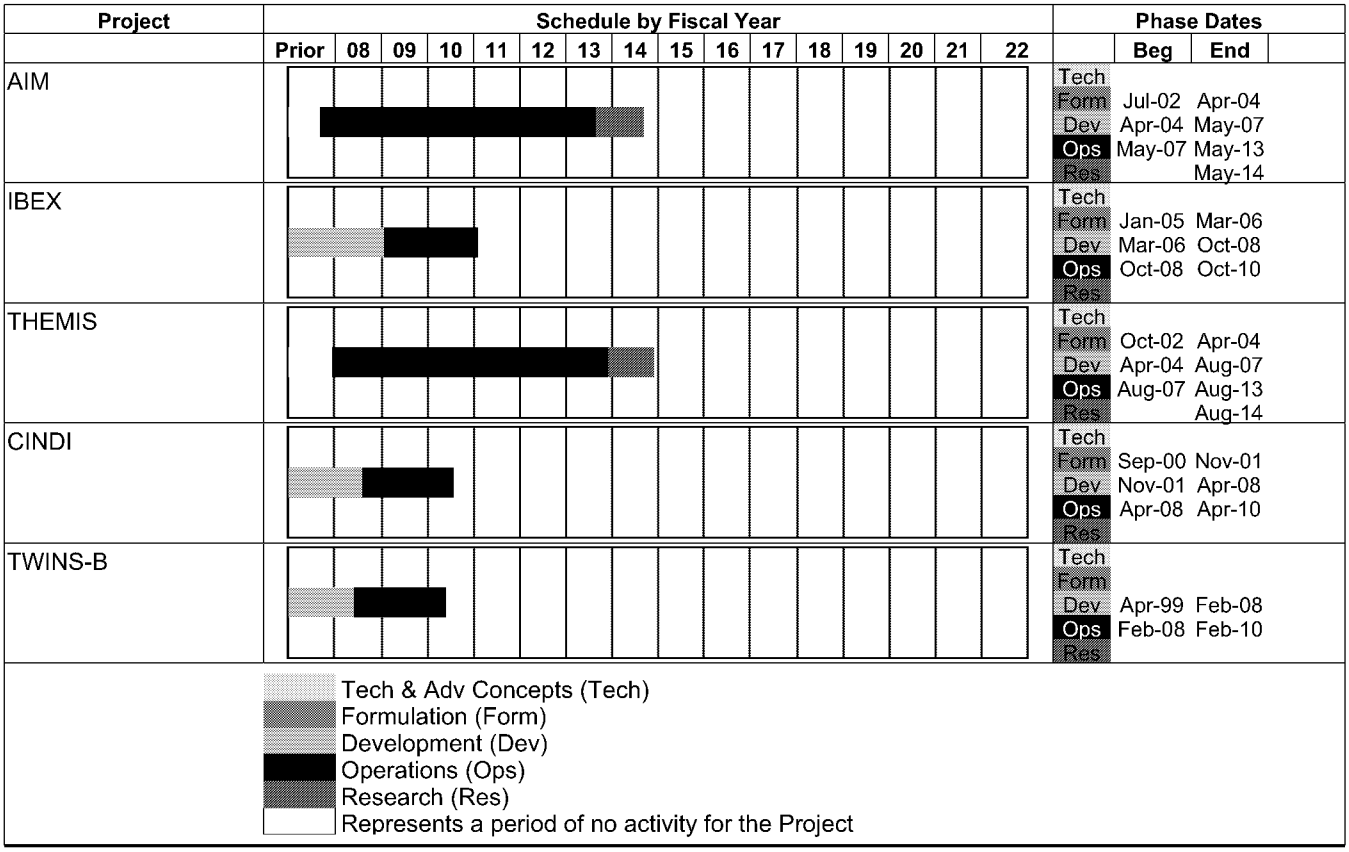
Explorer Future Missions: This project holds funding to be used for all future Explorer mission selections. Once a mission is selected, funding is moved into a new project.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Select up to two new SMEX missions (SMEX-12 and -13) from the most recent Announcement of Opportunity	Explorer Future Mission	None

Implementation Schedule



Program Management

Goddard Space Flight Center (GSFC) has Program Management responsibility for all Heliophysics Explorer Programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
AIM	GSFC	None	N/A
IBEX	GSFC	GSFC	N/A
THEMIS	GSFC	None	N/A
CINDI	GSFC	None	DoD
TWINS-B	GSFC	None	DoD
GOLD	GSFC	None	N/A

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Acquisition Strategy

The Heliophysics Explorer Program has established an acquisition strategy that contracts for the whole mission (concept through delivery of science data and analysis), with emphasis on performance incentives and a cost cap for each mission.

Investigations are selected through the Announcement of Opportunity (AO) process, where multiple investigations are selected competitively for initial concept studies with a competitive down-select to proceed to the next stage of formulation. The investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

The following awards have been made for development and mission operations:

IBEX: Orbital Science Corporation, Los Alamos National Laboratory, Lockheed Martin Advance Technology Center, Southwest Research Institute (mission operations).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Space Science Support Office	03/2008	Review and evaluate Small Explorers (SMEX) Announcements of Opportunity proposals for selection. Review will provide written evaluation for selection of two full SMEX missions and has already supported the selection of a Mission of Opportunity, the High-Resolution Soft X-Ray Spectrometer (SXS).	04/2009
Performance	IPAO	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the Explorer Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2011

THIS PAGE INTENTIONALLY BLANK

Mission Directorate:	Science
Theme:	Heliophysics
Program:	New Millennium

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	15.0	2.7	1.8	1.1	0.0	0.0	0.0
New Millennium	15.0	2.7	1.8	1.1	0.0	0.0	0.0
FY 2009 President's Budget Request	25.8	4.3	2.2	1.1	0.0	0.0	--
New Millennium	25.8	4.3	2.2	1.1	0.0	0.0	--
Changes from FY 2009 Request	-10.8	-1.6	-0.4	0.0	0.0	0.0	--

Program Overview

The New Millennium Program (NMP) is a technology flight validation program designed to mature key emerging and breakthrough technologies that will enable future NASA science missions. The objective of the program is to accelerate the incorporation of new technologies into future NASA science missions by conducting in-space validation and testing. The NMP allows NASA to conduct technology maturation and validation activities in low cost projects, rather than during science mission development of larger, more expensive missions.

The NMP is being phased out and all current activities will be finished by FY 2012. A small amount of funding remains to cover closeout costs.

For more information, please see: http://nmp.jpl.nasa.gov.

Plans For FY 2010

Space Technology 7 micro-valve assembly will be launched on an European Space Agency (ESA) spacecraft. Program closeout activities will continue.

Project Descriptions and Explanation of Changes

New Millennium

Space Technology 7's Disturbance Reduction System (DRS) incorporates enhanced micro-Newton thruster technology, which works with enhanced sensor technology provided by the European Space Agency. Together, these technologies will demonstrate precision spacecraft control, validating position-measurement of objects in weightlessness with 100-times greater accuracy than ever before.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	New Millennium

Implementation Schedule

Project	Schedule by Fiscal Year															Phase Dates		
	Prior	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22		Beg	End
Space Technology 7																	Tech	Apr-01	Apr-03
																	Form	Apr-03	Jul-03
																	Dev	Jul-03	Jan-10
																	Ops	Jan-10	Jan-11
																	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The New Millennium Program is managed by Jet Propulsion Laboratory.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Space Technology 7	JPL	JPL	European Space Agency and Busek Corporation

Acquisition Strategy

No further acquisitions are planned.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	01/2007	Program Implementation Review. Results were reported to the Agency PMC on 9/12/2007. Review concluded that there should be more emphasis on technology infusion.	N/A